

WHAT IS CLAIMED IS:

1. A method of forming ceramic capillary ribs, comprising the steps of:  
forming a ceramic paste film by coating a ceramic paste on [the] a surface of a  
substrate; and

5 moving one of a blade and said substrate in a predetermined direction in a state in  
which comb-teeth formed on at least a part of said blade are thrust into said paste film,  
thereby forming ceramic capillary ribs on the surface of said substrate.

2. A method of forming ceramic capillary ribs, comprising the steps of:  
forming a ceramic paste film by coating a ceramic paste on a surface of a substrate;

10 and

moving one of a blade and said substrate in a predetermined direction in a state in  
which comb-teeth formed on at least a part of said blade are thrust into said paste film,  
thereby forming a ceramic capillary layer on the surface of said substrate and ceramic  
capillary ribs on said ceramic capillary layer.

15 3. A ceramic paste used for a method of forming ceramic capillary ribs according to  
claims 1 or 2, wherein the step of forming the paste comprises forming a paste containing a  
glass powder or glass/ceramic mixed powder in an amount of from 30 to 95 wt.%, a resin in  
an amount of from 0.3 to 15 wt.%, and a solvent mixture containing a solvent, a plasticizer  
and a dispersant in an amount of from 3 to 70 wt.%.

20 4. A ceramic paste according to claim 3, wherein-said resin is comprises one of a  
thermosetting resin and a photosetting resin.

1714  
25 5. A ceramic paste according to claim 4, wherein said thermosetting resin comprises  
at least one resin selected from the group consisting of phenol resin, urea resin, melamine  
resin, alkyd resin, silicone resin, furan resin, unsaturated polyester resin, epoxy resin and  
polyurethane resin.

6. A ceramic paste according to claim 4, wherein said photosetting resin comprises at least one resin selected from the group consisting of benzophenone resin, dibenzyl ketone resin, diethylthioxanthone resin, anthrone resin, and dibenzosuberone resin.

7. A ceramic paste according to claim 3, wherein said resin comprises one of a self-setting resin which polymerization-reacts with a solvent and causes with time an increase in paste viscosity, and resin which contains a self-setting resin.

8. A ceramic paste according to claim 7, wherein said resin and said solvent comprises one of a water-soluble epoxy resin containing triethylenetetramine, PVA and formaldehyde, and a water-insoluble epoxy resin containing xylenediamine, respectively.

9. A ceramic paste according to claim 3, wherein said solvent contained in said solvent mixture comprises one of a plurality of kinds of solvent having boiling points which are different from each other by more than 30°C.

10. A ceramic paste according to claim 3, wherein the paste further contains a degassing agent in addition to the solvent, the plasticizer and the dispersant contained in the solvent mixture.

11. An apparatus for forming ceramic capillary ribs, comprising:

- a base horizontally supporting the substrate;
- a moving head horizontally movably positioned above said base;
- a blade holder attached to said moving head;
- a blade held by said holder at a position opposite said substrate and at right angles to a direction of moving of said moving head, wherein a lower part of the blade includes comb-teeth held horizontally; and
- an actuator causing said moving head to move horizontally;

wherein a ceramic capillary rib is formed on a surface of said substrate by horizontally moving said blade by thrusting said comb-teeth into the ceramic paste film formed on the surface of said substrate.

5 12. An apparatus for forming ceramic capillary ribs according to claim 11, wherein said blade holder is vertically movably attached to the moving head via holder depressing means which pushes down said blade holder so that the lower ends of the comb-teeth are in contact with the substrate under a predetermined pressure.

10 13. An apparatus for forming ceramic capillary ribs according to claim 12, wherein a pair of holder depressing means are provided on the moving head at one of a position[s] corresponding to [the both] opposite ends of the blade [or to] and a position[s] [near the both] in proximity with said opposite ends.

14. An apparatus for forming ceramic capillary ribs according to claim 11, wherein: said blade holder is vertically movably attached to the moving head via blade adjusting means for adjusting the vertical position of the lower ends of the comb-teeth;

15 said moving head is provided with position sensors for detecting one of a displacement of the substrate surface relative to a reference position of the substrate surface, and a displacement of the ceramic paste film surface relative to a reference position of the ceramic paste film surface; and

20 wherein a controller is provided for controlling said blade adjusting means by the use of the detection output of said position sensors.

15. An apparatus for forming ceramic capillary ribs according to claim 14, wherein a pair of blade adjusting means are provided on the moving head at positions corresponding to one of opposite ends of the blade and positions in proximity with each of said ends.

25 16. An apparatus for forming ceramic capillary ribs according to claims 14 or 15, wherein said position sensor detects one of a displacement of the substrate surface and a displacement of the ceramic paste film ahead of the blade in the moving direction.

17. An apparatus for forming ceramic capillary ribs according to claims 14 or 15, wherein said position sensor detects one of a displacement of the substrate surface and a displacement of the ceramic paste film directly below the blade in a longitudinal direction.

18. A ceramic capillary rib formed by the use of the forming apparatus according to claim 11.

19. An apparatus for forming ceramic capillary ribs, comprising:

a base having a carriage horizontally supporting a substrate;

a fixed head positioned above said carriage;

a blade holder attached to said fixed head, and a blade held by said blade holder, opposite to said substrate and at right angles to a moving direction of said carriage, wherein a lower part of the blade includes comb-teeth directed horizontally; and

wherein said carriage is horizontally movable with said comb-teeth thrust into the ceramic paste film formed on the surface of said substrate, thereby forming ceramic capillary ribs on the surface of said substrate.

20. An apparatus for forming ceramic capillary ribs according to claim 19, wherein said blade holder is vertically movably attached to the fixed head via holder depressing means which pushes down said blade holder so that the lower ends of the comb-teeth are in contact with the substrate under a predetermined pressure.

21. An apparatus for forming ceramic capillary ribs according to claim 20, wherein a pair of holder depressing means are provided on the fixed head at positions corresponding to one of opposite ends of the blade and positions in proximity with said ends.

22. An apparatus for forming ceramic capillary ribs according to claim 19, wherein: said blade holder is vertically movably attached onto the fixed head via blade adjusting means for adjusting a vertical position of lower ends of the comb-teeth; said fixed head is provided with position sensors for detecting one of a displacement

of the substrate surface relative to a reference position of the substrate surface and a displacement of the ceramic paste film surface relative to a reference position of the ceramic paste film surface; and

a controller is provided for controlling said blade adjusting means by the use of the detection output of said position sensors.

23. An apparatus for forming ceramic capillary ribs according to 22, wherein a pair of blade adjusting means are provided on the fixed head at one of positions corresponding to the opposite ends of the blade and positions in proximity with said ends.

24. An apparatus for forming ceramic capillary ribs according to claims 21 or 22, wherein said position sensor detects one of said a displacement of the substrate surface and said displacement of the ceramic paste film ahead of the blade in the moving direction of the blade relative to the carriage serving as a reference.

25. An apparatus for forming ceramic capillary ribs according to claims 22 or 23, wherein said position sensor detects one of said displacement of the substrate surface and said displacement of the ceramic paste film directly below the blade in the longitudinal direction.

26. A ceramic capillary rib formed by to use of the forming apparatus according to claim 19.

27. A blade having comb-teeth formed on an edge thereof, used in the method for forming a ceramic capillary rib according to claims 1 or 2.

28. A blade according to claim 27, wherein said blade has a thickness (t) within a range of from 0.01 to 3.0 mm, and when the comb-teeth have a pitch P, the gap between the comb-teeth is W, and the gap has a depth h, these parameters are in relationship of  $0.03 \text{ mm} \leq h \leq 1.0 \text{ mm}$  and  $W/P \leq 5-0.9$ .

29. A blade according to claim 27, wherein the gaps of the comb-teeth comprise one

of rectangular shaped gaps, trapezoidally shaped gaps, and inverted trapezoidally shaped gaps.

30. A ceramic rib formed on a substrate, wherein: when the height of said rib is  $H$ , the width of the rib at a height of  $1/2 H$  is  $W_c$ , the width of the rib at a height of  $3/4 H$  is  $W_M$ , and the width of the rib at a height of  $9/10 H$  is  $W_T$ ,

the dispersion of each of  $H$ ,  $W_c$ ,  $W_M$  and  $W_T$  as expressed as (maximum or minimum value - average value)/average value is up to 5%, and the aspect ratio as expressed as  $H/W_c$  is within a range of from 1.5 to 10.

31. A ceramic rib formed on an insulating layer formed on a substrate, wherein: when the height of said rib is  $H$ , the width of the rib at a height of  $1/2 H$  is  $W_c$ , the width of the rib at a height of  $3/4 H$  is  $W_M$ , and the width of the rib at a height of  $9/10 H$  is  $W_T$ , the dispersion of each of  $H$ ,  $W_c$ ,  $W_M$  and  $W_T$  as expressed as (maximum or minimum value - average value)/average value is up to 5%, and the aspect ratio as expressed as  $H/W_c$  is within a range of from 1.5 to 10.

32. An FPD having ceramic ribs prepared by firing ceramic capillary ribs formed by the method according to claim 1.

33. An FPD having ceramic ribs formed on an insulating layer prepared by firing a ceramic capillary layer and ceramic capillary ribs formed by the method according to claim 2.

34. A PDP which comprises a plurality of address electrodes formed in a plurality of rows are formed at prescribed intervals on a substrate, and plurality of ceramic ribs formed between said address electrodes in the plurality of rows, wherein:

an insulating layer covering said address electrodes is formed integrally with said ceramic rib on the substrate, and the insulating layer on the upper surface of said address electrodes has a thickness within a range of from 0 to  $20 \mu\text{m}$ .

35. A manufacturing method of PDP, comprising:  
forming a plurality of rows of address electrodes at prescribed intervals on a substrate;  
forming a ceramic paste film by coating a ceramic paste with a prescribed thickness  
on the surface of said substrate so as to cover said plurality of rows of address electrodes;  
5 forming a plurality of ceramic capillary ribs between said plurality of rows of address  
electrodes and forming a ceramic capillary layer covering said address electrodes by moving  
one of a blade and said substrate in a predetermined direction in a state in which comb-teeth  
formed along the edge of the blade are thrust into said paste film; and  
integrally forming an insulating layer covering said ceramic ribs and said address  
10 electrodes on said substrate by drying and then firing said ceramic capillary ribs and said  
ceramic capillary layer such that the insulating layer on the upper surface of said address  
electrodes has a thickness within a range of from 0 to 20  $\mu\text{m}$ .

36. An apparatus for forming ceramic capillary ribs according to claim 11, wherein  
said blade holder is vertically movably attached to the moving head via a holder depressing  
15 mechanism which pushes down the blade holder so that the lower ends of the comb-teeth are  
in contact with a substrate under a predetermined pressure.

37. An apparatus for forming ceramic capillary ribs according to claim 36, wherein a  
pair of holder depressing mechanisms are provided on the moving head at one of a position  
corresponding to opposite ends of the blade and a position in proximity with said opposite  
20 ends.

38. An apparatus forming ceramic capillary ribs according to claim 11, wherein said  
blade holder is vertically movably attached to the moving head via a blade adjusting  
mechanism adjusting the vertical position of the lower ends of the comb-teeth;

said moving head is provided with position sensors detecting one of a displacement of  
25 the substrate surface relative to a reference position of the substrate surface and a  
displacement of the ceramic paste film surface relative to a reference position of the ceramic  
paste film surface; and

wherein a controller is provided for controlling said blade adjusting mechanism by use

of the detection output of said position sensors.

39. An apparatus for forming ceramic capillary ribs according to claim 38, wherein a pair of blade adjusting mechanisms are provided on the moving head at positions corresponding to one of opposite ends of the blade and positions in proximity with each of said ends.

40. An apparatus for forming ceramic capillary ribs according to claims 38 or 39, wherein said position sensor detects one of a displacement of the substrate surface and a displacement of the ceramic paste film ahead of the blade in the moving direction.

41. An apparatus for forming ceramic capillary ribs according to claims 38 or 39, wherein said position sensor detects one of a displacement of the substrate surface and a displacement of the ceramic paste film directly below the blade in a longitudinal direction.

42. An apparatus for forming ceramic capillary ribs according to claim 19, wherein said blade holder is vertically movably attached to the fixed heads via a holder depressing mechanism which pushes down said blade holder so that the lower ends of the comb-teeth are in contact with a substrate under a predetermined pressure.

43. An apparatus for forming ceramic capillary ribs according to claim 42, wherein a pair of holder depressing mechanisms are provided on the fixed head at positions corresponding to one of both ends of the blade and a position in proximity with said ends.

44. An apparatus for forming ceramic capillary ribs according to claim 19, wherein:  
said blade holder is vertically movably attached onto the fixed head via a blade adjusting mechanism adjusting a vertical position of lower ends of the comb-teeth;  
said fixed head is provided with position sensors detecting one of a displacement of the substrate surface relative to a reference position of the substrate surface and a displacement of the ceramic paste film surface relative to a reference position of the ceramic paste film surface; and



a controller is provided controlling said blade adjusting mechanism by the use of the detection output of said position sensors.

45. An apparatus for forming ceramic capillary ribs according to claim 44, wherein a pair of blade adjusting mechanisms are provided on the fixed head at one of positions corresponding to opposite ends of the blade at positions in proximity with said ends.

46. An apparatus for forming ceramic capillary ribs according to claims 43 or 44, wherein said position sensor detects one of a displacement of the substrate surface and a displacement of the ceramic paste film ahead of the blade in the moving direction of the blade relative to the carriage serving as a reference.

47. An apparatus for forming ceramic capillary ribs according to claims 44 or 45, wherein said position sensor detects one of said displacement of the substrate surface and said displacement of the ceramic paste film directly below the blade in the longitudinal direction.